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BUREAU OF PUBLIC ROADS

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ON THE COLUMBIA RIVER HIGHWAY IN OREGON

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BUREAU OF PUBLIC ROADS

G. P. St. CLAIR, *Editor*

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The reports of research published in this magazine are necessarily qualified by the conditions of the tests from which the data are obtained. Whenever it is deemed possible to do so, generalizations are drawn from the results of the tests; and, unless this is done, the conclusions formulated must be considered as specifically pertinent only to the described conditions.

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THE WESTERN STATES TRAFFIC SURVEY

Reported by L. E. PEABODY, Senior Highway Economist, U. S. Bureau of Public Roads

THE REPORT of a traffic survey of the Federal-aid highway system in the Western States has recently been published by the Bureau of Public Roads.[1] This survey was conducted by the bureau in cooperation with the State highway departments of Arizona, California, Colorado, Idaho, Nebraska, New Mexico, Nevada, Oregon, Utah, Washington, and Wyoming. The report gives the essential facts regarding the present density, types, capacities, and distribution of traffic units and forecasts of future traffic as a basis for planning highway development to serve present and future needs. A summary of the principal facts brought out by the survey is given in the following pages.

On the Ridge Route in California

SUMMARY OF CONCLUSIONS

1. Annual use of the Federal-aid highway system is approximately 8,400,000,000 vehicle-miles. Intensity of use per mile is greatest in California and least in Nevada. Travel is concentrated. For example, on U. S. 91 from Springville to Logan, Utah, comprising 6.6 per cent of the highway mileage of the State, is found more than 40 per cent of the total vehicle mileage in Utah, and more than 40 per cent of the truck mileage. In Nevada 64 miles of the Federal-aid system near Reno, 4.2 per cent of the total in the State, carries 25 per cent of the State's total vehicle mileage and about 17 per cent of the truck mileage.

2. Foreign traffic varies from 4.9 per cent of the total motor traffic in California to 38.5 per cent in Arizona, and averages 15 per cent throughout the whole area. Six of the eleven States have more than 20 per cent, and three States more than 30 per cent of foreign traffic. By foreign traffic is meant travel by vehicles from outside the particular State under discussion.

3. Trucks under 3 tons capacity constitute 85.5 per cent of all truck traffic; more than 50 per cent of all trucks operating in these States are in the 1 to 1½ ton group. Less than 6 per cent are 5-ton or over. California has the heaviest truck traffic, with 23.1 per cent in the group of 3 tons and over; New Mexico has the smallest number of heavy trucks, with 5.2 per cent having capacities of 3 tons and over.

4. Nearly half of all trucks travel under 80 miles per day; 12 per cent travel in excess of 200 miles per day. The average daily travel is 103 miles, the median daily travel 82 miles. The proportion of foreign trucks making exceptionally long trips to total foreign trucks is nearly five times the proportion of local trucks making similar trips. The average travel of foreign trucks is 154 miles, more than one and one-half times the average daily travel of local trucks.

5. Approximately one-half of all trucks are city owned. The remaining half is nearly equally divided among owners living in villages (under 2,500 population) or on farms. In Wyoming, a State with large areas of unproductive land and a small population largely concentrated in villages along the highways and railroads, only 23 per cent of the trucks are city owned, 34 per cent are village owned, and 43 per cent are farm owned. California is at the other extreme with two large urban areas and numerous smaller cities. Here

[1] Copies may be obtained from the Superintendent of Documents, Government Printing Office.

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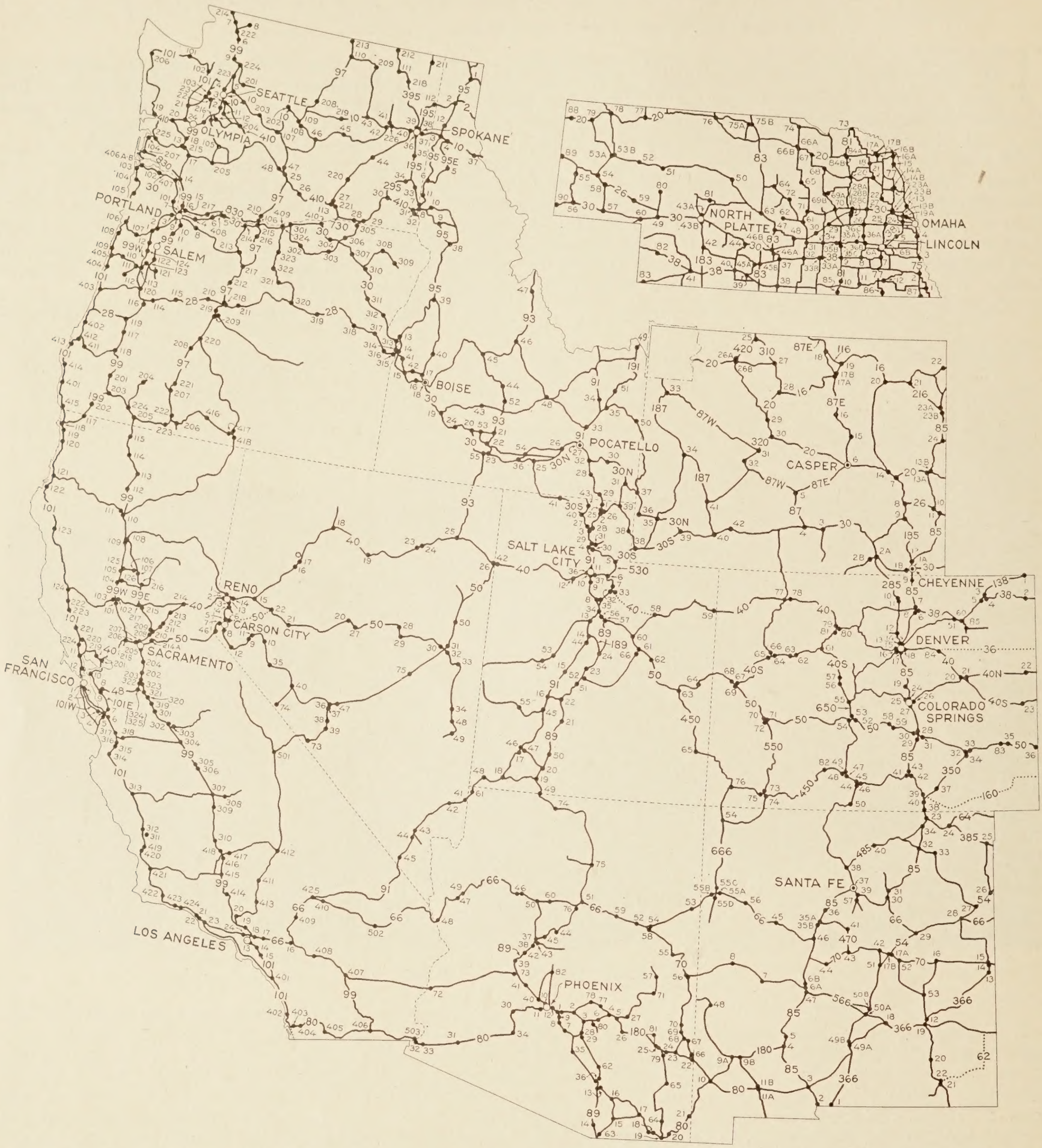

FIGURE 1.—HIGHWAY MAP OF 11 WESTERN STATES, SHOWING LOCATION OF TRAFFIC RECORDING STATIONS. U. S. HIGHWAY NUMBERS ARE SHOWN IN BOLD NUMERALS, NUMBERS OF RECORDING STATIONS IN LIGHT NUMERALS

city-owned trucks are 66 per cent of the total, and the remainder is divided equally between farms and villages. There is definitely a greater proportionate use of the highways by rural trucks than by urban trucks.

6. The effect of physical barriers upon truck traffic is pronounced. Most foreign trucking originates in adjoining States.

7. Eighty-six per cent of all trucks are operated by their owners; contract haulers operate 8.7 per cent, and common carriers operate 5.5 per cent of all trucks. The proportion of owner-operated trucks is six times that of commercial trucks. Common-carrier trucks constitute less than 1½ per cent of all motor traffic. Approximately 80 per cent of common carriers are engaged in intrastate hauling. Variation in demand for common-carrier service among the States is dependent mainly upon the variations in density and distribution of population within the area, and upon the amount of registration fee charged by the State. A comparison of common-carrier traffic with the num-

ber of such carriers registered indicates an intensity of usage of common carriers about four times that of all trucks.

8. Approximately 57 per cent of all passenger cars travel less than 140 miles per day; 4 per cent travel 400 miles or more per day. The average daily mileage of passenger cars is nearly 50 per cent greater than the average daily mileage of trucks. The average daily travel of foreign passenger cars is nearly double that of local passenger cars. Ten per cent of foreign passenger cars travel over 400 miles per day.

9. In but three States, Nebraska, Nevada, and Wyoming, does the proportion of city-owned passenger cars fall below 50 per cent; in California the proportion is 73.2 per cent. In the whole area city-owned passenger cars constitute 61 per cent. A comparison of truck and passenger car situs of ownership indicates that in every State the proportion of city-owned cars is much higher than that of city-owned trucks. City-owned cars travel an average of 169 miles per day; village-owned cars, 129 miles per day; farm-owned cars, 99 miles per day.

10. Passenger-car traffic is less affected than truck traffic by difficult topography or climate. More than one-seventh of the foreign passenger-car traffic in the Western States originates east of the Mississippi River.

11. The number of passengers per car averages 2.42, with slight variation in the average among individual States. Nearly two-thirds of all passenger cars carry either one or two passengers.

12. The Federal-aid highways of the 11 States were classified upon the basis of present traffic and traffic forecasts for 1935 and 1940. Routes or sections of routes carrying 1,500 or more motor vehicles per day are classed as major routes, those carrying 600 to 1,500 per day as intermediate routes, and those carrying less than 600 vehicles daily are classed as minor routes. The routes or sections of routes are grouped in this way on the basis of observed 1930 traffic, and the estimated traffic for 1935 and 1940 is employed in a similar manner to indicate the probable classification in those years.

Slightly over 11 per cent of the Federal-aid highways carried over 1,500 motor vehicles per day in 1930. Nearly one-half of the mileage classed as major lies in the State of California, about one-fifth is located in Washington, and the remainder is scattered mainly in short sections throughout the other States.

Eighteen per cent of the mileage carried between 600 and 1,500 motor vehicles per day in 1930, about one-quarter of which was in the State of Nebraska, with nearly as much mileage of intermediate classification in California.

The remaining 66 per cent of the classified mileage carried less than 600 motor vehicles per day in 1930. Five per cent of the Federal-aid system could not be classified.

In 1935 the respective mileage classifications are expected to be as follows: major 14 per cent; intermediate, 22 per cent; minor, 59 per cent. The expected classification for 1940 is as follows: major, 16 per cent; intermediate, 25 per cent; minor 54 per cent.

THE METHODS OF THE SURVEY DESCRIBED

The traffic survey was begun in September, 1929, in all States except Washington and Nevada, where field operations were instituted in October and November, respectively. Traffic data was recorded at 899 points in the 11 States with locations as shown in Figure 1.

In addition to counting the volume of traffic in each classification of vehicles and upon each route, field men stopped each motorist and distributed franked cards which were returned to the Bureau of Public Roads. By means of these cards information was obtained regarding the day's mileage traveled, the origin and destination of the vehicle, the number of passengers carried, the capacity of trucks, the situs of ownership (farm, village, or city) and the State of registration. During the last three months of field operations traffic recorders questioned drivers of trucks, obtained the names of owners, classified them as owner-operators, contract haulers or common carriers, and determined whether operations were interstate or intrastate. Busses were classified simply as interstate or intrastate.

DETAILED TRAFFIC DATA

The average daily traffic upon the highways in the Western States is presented graphically in Figure 2. In the Pacific Coast States is found the largest mileage of highway carrying over 1,500 motor vehicles per day, totaling more than 3,000 miles. The traffic on U. S. Highway 99 is continuously above 1,500 vehicles per day from Indio to Sacramento and from Eugene, Oreg., to Ferndale, Wash., throughout more than two-thirds of its entire length. Between Los Angeles and Bakersfield there is an average of 300 trucks per day. The transportation of oil-well supplies to the oil fields near Bakersfield, and of cotton, hay, and milk to Los Angeles make this an extremely important section from the standpoint of weight of traffic. In addition to the long-haul truck traffic on U. S. 99 between northern and southern California, there is a great deal of local trucking between the cities of the densely populated San Joaquin Valley. From Bakersfield north to Stockton the average daily volume of trucks varies from 400 immediately north of Bakersfield to more than 1,000 trucks per day at Fresno. The average daily travel of trucks on this route is 140 miles and the median daily travel 120 miles, considerably higher than the average and median for all trucks in California.

Approximately one-half the mileage of U. S. 101, between San Diego and Healdsburg, Calif., and a few short sections near cities, carries 1,500 or more motor vehicles per day. The greatest volume of truck traffic is found south of Los Angeles between that city and Whittier, a total of nearly 1,400 trucks per day passing over this section, of which more than 350 are trucks of greater than 3-ton capacity. The greater portion of this traffic is local, as the number of trucks decreases rapidly south of Whittier, but the average between Whittier and San Diego is about 400 trucks per day, and the number of heavy trucks is but slightly less than 100 per day. The average and median daily mileage traveled by trucks on this route between Los Angeles and San Francisco are 120 and 100 miles, respectively.

Colorado has more than 300 miles of highway with a density of 1,500 or more vehicles daily, the mileage being distributed over sections of several routes—U. S. 85, Pueblo to Greeley; U. S. 50, La Junta to Pueblo; and U. S. 285, Denver to Fort Collins. These sections form a continuous route with traffic of this volume from La Junta to Greeley via Denver, and from Denver to Fort Collins.

With the exception of a section from Provo to Brigham, Utah, 104 miles in length, and a few short sections near the cities of Arizona, Idaho, Nebraska, Nevada, and New Mexico, the remainder of the mileage carries less than 1,500 motor vehicles per day.

FIGURE 2.—AVERAGE DAILY DENSITY OF TRAFFIC ON THE HIGHWAYS OF THE WESTERN STATES, 1929–1930

FOREIGN TRAFFIC

The percentage of foreign traffic within each State is given in Table 1. These percentages are the ratio of foreign vehicle-miles to total vehicle-miles. It should be noted that a small percentage does not necessarily indicate a small volume of foreign traffic.

The average daily flow of foreign traffic for all States is shown graphically in Figure 3. A comparison of the traffic-flow map (fig. 2) with the foreign traffic-flow map (fig. 3) reveals some interesting contrasts. On U. S. 80 at the California-Arizona line, the volume of foreign traffic on the Arizona side is half again as large as that upon the California side of the border, because of the

TABLE 1.—*Average daily foreign traffic in Western States, expressed in vehicle-miles and in percentage of average total daily traffic*

State	Daily foreign vehicle-miles	Percentage of total vehicle-miles	State	Daily foreign vehicle-miles	Percentage of total vehicle-miles
Arizona	347, 000	38. 5	New Mexico	405, 000	37. 6
California	412, 000	4. 9	Oregon	434, 000	22. 1
Colorado	331, 000	14. 9	Utah	116, 000	14. 3
Idaho	220, 000	22. 4	Washington	358, 000	11. 4
Nebraska	303, 000	12. 7	Wyoming	239, 000	28. 5
Nevada	90, 000	31. 0			

FIGURE 3.—AVERAGE DAILY DENSITY OF FOREIGN TRAFFIC IN THE WESTERN STATES, 1929–1930

large number of cars from the latter State traveling to Yuma. Still more noticeable are the changes in volume of foreign traffic on U. S. 99 as it passes the California-Oregon and Oregon-Washington boundaries. At the California-Oregon line local traffic from California to Ashland and Grants Pass increases the volume of foreign traffic in Oregon to approximately twice that in California, while at the Oregon-Washington line local traffic from Vancouver, Wash., to Portland, Oreg., is responsible for a foreign density in Oregon more than three times that in Washington. This latter difference and those in the immediate vicinity of the Oregon-Idaho border near Weiser and Ontario, Idaho, are not shown upon the map, as the sections are short in length and large in width, and to show them would so distort the map as to blot out other important data.

VARIATIONS IN TRAFFIC DENSITY

Traffic density varies from the averages of the flow maps on any particular day, or during the various seasons of the year and is abnormally high because of fairs, football games, or other sporting events producing exceptional movement. Aside from such abnormal movements, traffic density reaches its normal maximum during the month of August in all States except Arizona, where the month of heaviest travel is March, and in Utah, where September is the month of maximum traffic. A more valuable picture of the variation by seasons of the year, and one which does not accentuate the extremes, is given by the ratio of the average traffic during the six months of heaviest traffic to that during the six months of lightest traffic. The ratios of summer to winter traffic are presented by States for passenger cars and trucks separately in Figures 4 and 5. These data bring out very sharply the effect of climatic differences upon traffic flow; for example, Arizona's passenger-car traffic varies but 7 per cent between winter and summer, while Wyoming's severe winters are reflected in an 89 per cent variation between the two seasons. For truck traffic the figures are somewhat similar, although the comparison of truck traffic at different seasons is seriously affected by the presence or absence of large population centers or industrial areas. Truck traffic is less responsive to seasonal changes. The extreme seasonal variation is best illustrated by Wyoming's passenger-car traffic, which shows an increase of 247 per cent from January to August.

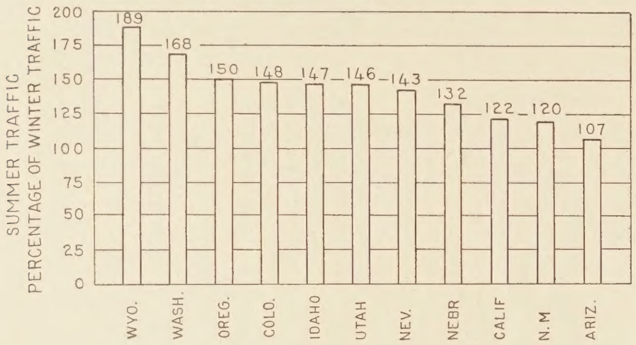

Figure 4.—Comparison of Summer and Winter Passenger-Car Traffic

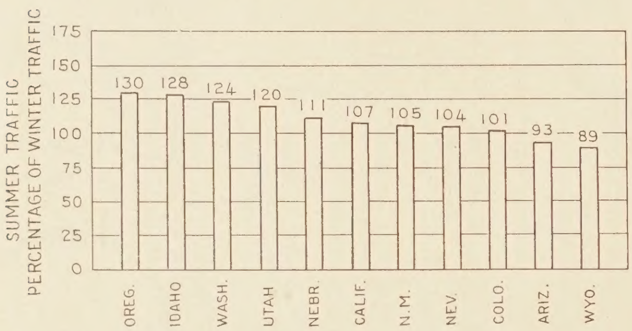

Figure 5.—Comparison of Summer and Winter Truck Traffic

U. S. 87, north of Moran, Wyo., illustrates the effect of winter conditions upon traffic flow. Here the average daily density for the winter season is but 8 per cent of that for the entire year. The flow of traffic into Yellowstone Park during the summer months tends to raise the yearly average and depress proportionately the winter average. U. S. 50, south of Glenbrook, Nev., and U. S. 191, north of Trude, Idaho, are other examples. On U. S. 10, north of Virden, Wash., the winter ratio is but 25 per cent of the yearly average, because of winter traffic avoiding Blewett Pass.

In some portions of the southern States of this group the situation is reversed and average winter traffic exceeds the annual average by as much as 26 per cent.

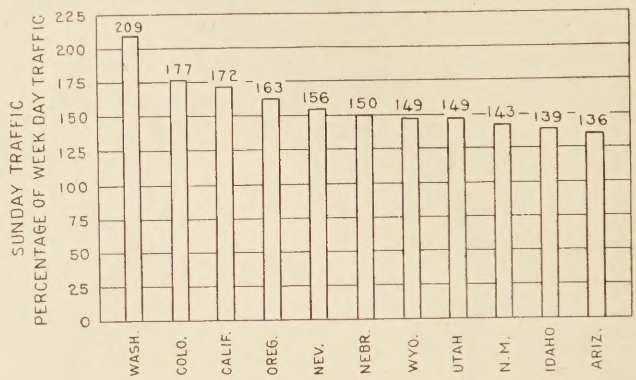

Figure 6.—Comparison of Sunday and Week-Day Passenger-Car Traffic

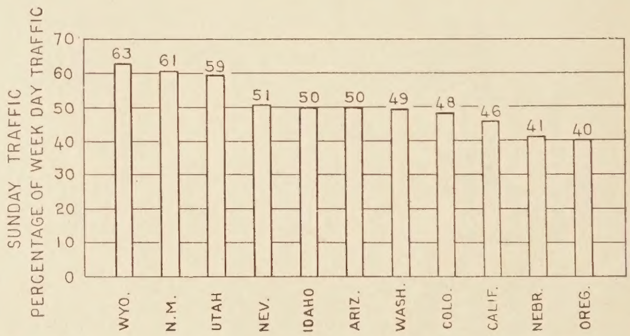

Figure 7.—Comparison of Sunday and Week-Day Truck Traffic

A high winter average may be due to causes other than travel of winter tourists; for example, on U. S. 180, east of Silver City., N. Mex., truck traffic to copper mines tends to keep the winter average high.

Passenger-car traffic is greater on Sunday than on any other day of the week in all States, while truck traffic is less on Sunday in every State. The ratios of Sunday to average week-day traffic are given for passenger cars and trucks in Figures 6 and 7.

TRUCK TRAFFIC

Highway design and location are dependent not only upon the volume of traffic to be served, but also upon the unit weight of this traffic. In problems which concern the free movement of traffic, such as the width of pavement, the necessity for parallel routes, or the elimination of grade crossings and "bottle necks," density of traffic is the most important factor. In the problems of designing the section or of selecting the most economical pavement, weight of traffic as well as density must be considered. A relatively small highway mileage in each State carries the greatest amount of heavy trucking. Truck traffic upon the highways of the 11 States, including the average daily density of trucks with capacities of 3 tons and over, is presented graphically in Figure 8.

Light trucks are far more numerous than those of any other type on the highways in the Western States. Trucks ranging from 1 to 1½ ton capacity form the most

Figure 8.—Average Daily Density of Truck Traffic in the Western States, 1929–1930, Including Density of Heavy Truck Traffic. Width Between Lines Indicates Density of Total Truck Traffic and Symbols Indicate Density of Heavy-Truck Traffic

important group in all States of the survey, and represent more than 50 per cent of all trucks operating in these States. The use of very light delivery trucks and of trucks of slightly greater than 1½-ton capacity is also extensive, trucks of less than 1-ton capacity forming 14.2 per cent and trucks of 2 to 2½ ton capacity forming 17.6 per cent of all trucks. Light trucks of less than 3-ton capacity comprise 85.5 per cent of all trucks. Trucks of greater than 3-ton capacity, while comprising but 14.5 per cent of all trucks, are far more important from the standpoint of highway design. Table 2 gives in detail the relative number of trucks of the various capacities observed on the highways of each State and also the combined percentages for the total number of trucks observed. These percentage distributions are shown graphically in Figure 9. The largest

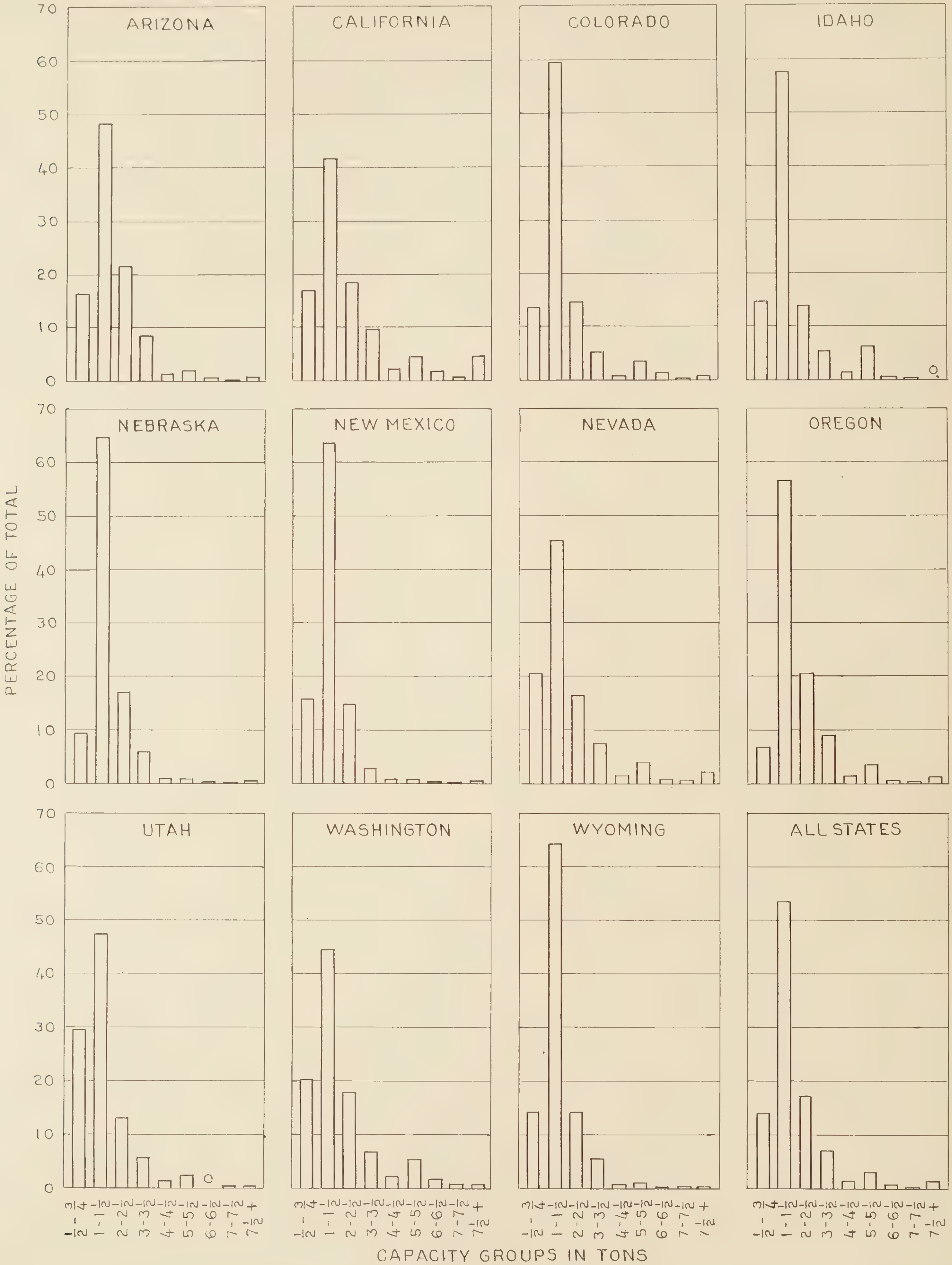

Figure 9.—Percentage Distribution of Truck Traffic by Capacity. Total Truck Traffic in Each State Represents 100 Per Cent

group in every instance is the 1 to 1½ ton group, but there are significant differences in the relative importance of light and heavy trucks in different States. The relative use of heavy trucks is greatest in California, 23.1 per cent, and least in New Mexico, the percentage being 5.2. Other States where the relative use of heavy trucks is higher than the average are Washington, Nevada, and Oregon; in Arizona, Colorado, and Idaho the percentage of heavy trucks is slightly less than the average. There is considerably less than the average percentage of heavy trucks in Nebraska, Utah, Wyoming and New Mexico.

An indication of the daily mileages traveled by trucks is obtained by a comparison of the average and median daily mileage of trucks (Table 3). The arithmetic average for all States is 103 miles, but this average is heavily weighted by a small number of trucks which make unusually large daily mileages. Daily mileage is the distance traveled per day and is not the distance from a single origin to a single destination during that day. The median daily mileage, a distance so computed that one-half of all trucks travel less and one-half travel more than this distance, is unaffected by the smaller number of vehicles which make longer daily mileages and hence is a better measure of the average daily mileage. The median for all States is 82 miles, 21 miles shorter than the arithmetic mean. While 80 miles is not usually considered a short haul, it must be remembered that this distance is the mileage per day on rural highways, and that it usually represents one or more round trips from origin to destination.

There is an important long daily movement reflected by the 12 per cent of all trucks which travel distances in excess of 200 miles per day.

Only one-third of all foreign trucks travel less than 100 miles per day; fully one-third travel from 100 to 200 miles; while one-fifth travel between 200 and 300 miles; and one-tenth exceed 300 miles per day. As but 2.3 per cent of local trucks exceed 300 miles per day, the proportion of foreign trucks making exceptionally long trips to total foreign trucks is more than four times the proportion of local trucks making similar trips.

Truck Traffic on Western Highways

Table 2.—*Percentage distribution of trucks by capacity*

Capacity group (tons)	Arizona	California	Colorado	Idaho	Nebraska	New Mexico	Nevada	Oregon	Utah	Washington	Wyoming	All States
½ to ¾	16.5	16.8	13.7	14.8	9.4	16.0	20.5	6.7	29.6	20.2	14.2	14.2
1 to 1½	48.2	41.8	59.8	57.7	65.0	63.8	45.6	56.4	47.6	44.4	64.1	53.7
2 to 2½	21.7	18.3	14.8	14.0	17.1	15.0	16.7	20.3	13.1	17.9	14.1	17.6
3 to 3½	8.9	9.7	5.1	5.4	6.0	2.9	7.7	9.1	5.7	6.9	5.3	7.3
4 to 4½	1.2	2.2	.8	1.4	1.0	.8	1.4	1.5	1.3	2.2	.5	1.4
5 to 5½	2.1	4.5	3.3	6.2	.8	.8	4.1	3.6	2.3	5.2	.9	3.2
6 to 6½	.3	1.8	1.7	.4	.2	.2	1.0	.7	0	1.7	.3	.9
7 to 7½	.2	.4	.3	.1	.1	.1	.5	.3	.2	.8	.3	.3
Over 7½	.9	4.5	.5	0	.4	.4	2.5	1.4	.2	.7	.3	1.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SUMMARY OF LIGHT AND HEAVY TRUCKS												
Under 3 tons	86.4	76.9	88.3	86.5	91.5	94.8	82.8	83.4	90.3	82.5	92.4	85.5
3 tons and over	13.6	23.1	11.7	13.5	8.5	5.2	17.2	16.6	9.7	17.5	7.6	14.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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TABLE 3.—*Average [1] and median [2] daily mileage of trucks*

State	Foreign		Local		All trucks	
	Average mileage	Median mileage	Average mileage	Median mileage	Average mileage	Median mileage
Arizona	170	146	96	75	109	82
California	181	162	106	85	107	85
Colorado	168	150	93	74	98	77
Idaho	147	133	90	70	100	78
Nebraska	153	132	109	93	114	97
New Mexico	153	142	89	73	103	82
Nevada	136	119	76	63	87	69
Oregon	145	125	101	80	106	83
Utah	155	139	97	82	102	87
Washington	142	126	89	74	92	75
Wyoming	155	138	87	71	97	76
All survey States	154	137	98	78	103	82

[1] Arithmetic average of daily mileages of vehicles.
[2] A distance so chosen that one-half of the vehicles travel more than this distance in a day and one-half travel less.

Rural population, defined by the Bureau of the Census to include the population of villages under 2,500 as well as the population actually on farms, comprises 42.7 per cent of the total population of the 11 States. Trucks of rural ownership, as above defined, were found to include 53.3 per cent of all trucks on the highway system. Urban population, 57.3 per cent of the total, is represented by 46.7 per cent of all trucks using the highways. Thus there is definitely a greater proportionate use of the highways by rural trucks than by urban trucks. This relationship holds for all States of the survey in varying degree, except in Arizona, New Mexico, and Idaho, where the proportion of rural trucks is less than the proportion of rural population. In these three States there is a large proportion of foreign trucks which undoubtedly increase the percentages of city-owned trucks, since the majority of long-distance interstate trucking lines are city owned.

Approximately half of Arizona's foreign truck traffic originates in southern California, while a large part of the remainder is contributed by El Paso, Tex. In New Mexico one-half the foreign truck traffic originates in Texas, clearly indicating the influence of El Paso, while Colorado also contributes a large share via Walsenburg and Trinidad. The proximity of the cities of Salt Lake City, Brigham, and Ogden in Utah, and Spokane, Wash., raises the percentage of city-owned trucks traveling upon Idaho highways.

FORECASTS OF HIGHWAY TRAFFIC IN THE WESTERN STATES

Planned highway construction—widening, new construction, or reconstruction of old routes and pavements—must provide for future use as well as for present traffic.

There is little question as to the desirability of the higher types of pavement, but funds necessary for the universal construction of such types are not now available. Roads that are too highly improved are as uneconomic as those that are inadequate for traffic demands. Because of this fact, estimates of future traffic are essential in the development of a plan of highway improvement.

Traffic forecasts based solely on past traffic trends can not generally be made, as reliable traffic data for a series of years are available only in a few States. Limited past traffic data may be used in a reasonable forecast of probable future traffic where the factors of population, registration, and gasoline consumption are available. Since these needed factors are obtainable in all the Western States, a means of estimating the probable future traffic in each is present, even though no traffic series is available.

Traffic forecasts in previous reports of the Bureau of Public Roads [2] were based on estimates of registration and population. Trends of traffic and motor vehicle registration were shown for Massachusetts, Maryland, Maine, Michigan, and Wisconsin. Registration was estimated by projecting the trend of persons per car. This method was used in forecasting probable registration in the Western States.

HEAVY TRAFFIC ON CALIFORNIA 60 NORTH OF SANTA MONICA CANYON IN LOS ANGELES COUNTY

Gasoline consumption is more closely related to volume of traffic than is registration, but statistics of gasoline consumption can be obtained only for very recent years, since the institution of a fuel tax. It was therefore necessary to use a combination of these several factors.

Increased travel per car and the amount of use of a State's highways by foreign vehicles are both reflected in increased gasoline consumption within that State, although the motor-vehicle registration of the State is not affected by either of these factors. Numerous agencies of the motor-vehicle industry have published statements regarding the increasing use per car, some indicating an increased mileage per car for 1930 more than 60 per cent greater than in 1920, and these conclusions are supported by figures of increased fuel consumption per car.

The survey in the Western States (see Table 1) discloses that the range of foreign traffic is from 4.9 per cent of all traffic in California to 38.5 and 37.6 per cent in Arizona and New Mexico, respectively. The median State is Oregon, with 22.1 per cent of its traffic originating outside its boundaries. Only California has less

[2] Report of a Survey of Transportation on the State Highway System of Ohio, (1927); Report of a Survey of Transportation on the State Highway System of Connecticut (1926); The Maine Highway Transportation Survey, PUBLIC ROADS, vol. 6, No. 3, May, 1925.

than 10 per cent foreign traffic, while more than one-third of all traffic in Arizona and New Mexico comes from other States.

RELATIONSHIP OF GASOLINE CONSUMPTION, REGISTRATION, AND TRAFFIC

Since 1925 and 1926 gasoline consumption has increased more rapidly than registration in the Western States, as well as in the United States as a whole. This is clearly illustrated in Figure 10, in which the historical series of gasoline consumption, registration, and traffic have been plotted on logarithmic scale and moved together vertically to facilitate comparison of the rates of increase in two of the Western States.

Traffic data for the period 1923 to 1929 are available in Oregon. During this period registration in Oregon has increased 64.2 per cent; traffic, 101.2 per cent; and gasoline consumption by motor vehicles, 104.4 per cent. If 1929 is taken as the base year the percentage increases are as follows: Registration, 39.1 per cent; traffic, 50.3 per cent; gasoline consumption, 51.1 per cent. (Table 4.) It will be found by reference to Figure 10 that for the years from 1920 to 1924 the trends for motor vehicle registration and gasoline consumption are very similar. In 1924 these series begin to separate and the divergence continues to increase with the registration trend falling off while that of gasoline consumption continues to climb with the traffic trend.

TABLE 4.—*Comparison of motor vehicle registration, gasoline consumption, and highway traffic in Oregon, 1923–1929*

Year	Registration [1]	Index number	Gasoline consumption (gallons)	Index number	Traffic	Index number
1923	166, 412	100. 0	74, 395, 262	100. 0	86, 931	100. 0
1924	192, 629	115. 8	86, 212, 032	115. 9	110, 891	127. 6
1925	216, 553	130. 1	99, 718, 545	134. 0	120, 893	139. 1
1926	234, 134	140. 7	111, 739, 583	150. 2	137, 431	158. 1
1927	245, 705	147. 7	122, 979, 624	165. 3	146, 257	168. 2
1928	254, 415	152. 9	134, 228, 921	180. 4	163, 934	188. 6
1929	273, 270	164. 2	152, 079, 099	204. 4	174, 871	201. 2

[1] As reported to U. S. Bureau of Public Roads by State officials. In some instances a revision has been made of the figure originally reported in annual tabulations.

California has a 5-year series of traffic, gasoline consumption, and registration. Figure 10, presents trends of these factors. Here again the trends of gasoline consumption and traffic are very similar, while the registration curve, as in Oregon, is lower since 1926. During these five years, 1926 to 1930, traffic increased 39.3 per cent; registration 27.5 per cent; and gasoline consumption 40.9 per cent. If 1930 is used as a base year, the increases are as follows: Traffic, 28.2 per cent; registration, 21.6 per cent; and gasoline consumption, 29.0 per cent. Absolute and percentage figures are shown in Table 5. Further reference to California (fig. 10) brings out the interesting fact that during 1924, 1925, and 1926 gasoline consumption and registration trends were very much alike, but since 1926 they have diverged. Again the gasoline consumption trend follows more closely that of traffic.

All of the divergence of registration from traffic and gasoline consumption trends would not be accounted for by foreign traffic alone, since it amounts to but 4.9 per cent of all traffic in California. The greater use of the automobile throughout the year is another factor that is reflected in increased gasoline consumption.

Table 6, based on data for the State of Louisiana, further illustrates the fact that traffic is increasing at a

TABLE 5.—*Comparison of motor vehicle registration, gasoline consumption, and highway traffic in California, 1926–1930*

Year	Registration	Index number	Gasoline consumption (gallons)	Index number	Traffic [1]	Index number
1926	1, 600, 475	100. 0	825, 106, 169	100. 0	1, 751, 799	100. 0
1927	1, 693, 195	105. 8	928, 724, 702	112. 6	2, 003, 203	114. 4
1928	1, 799, 890	112. 5	985. 558, 974	119. 5	2, 188, 741	124. 9
1929	1, 974, 341	123. 4	1, 139, 736, 244	138. 1	2, 293, 720	130. 9
1930	2, 041, 356	127. 5	1, 162, 337, 545	140. 9	2, 440, 000	139. 3

[1] This series is an average of Sunday and Monday traffic in January at 583 stations. In January, 1930, an unusually heavy snow closed many roads during the traffic count. Sunday traffic decreased more than 20 per cent, but Monday traffic, with the same roads closed, showed an increase over the previous year. A slightly lower rate of increase than that of July, 1930, over July, 1929, traffic was used to interpolate the January, 1930, figure. Had the full rate of increase in July traffic been applied, the index number for traffic in 1930 would have been closer to the gasoline consumption index of 140.9, i. e., 140.3 instead of 139.3.

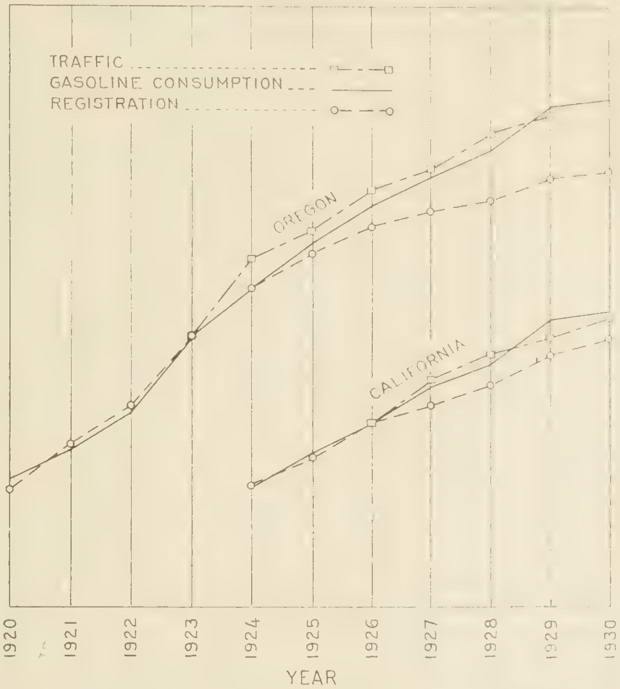


FIGURE 10.—TRENDS OF HIGHWAY TRAFFIC, GASOLINE CONSUMPTION, AND MOTOR VEHICLE REGISTRATION IN OREGON AND CALIFORNIA. THE VERTICAL SCALE IS LOGARITHMIC AND THE CURVES HAVE BEEN MOVED TOGETHER VERTICALLY FOR COMPARISON OF RATES OF INCREASE

faster rate than registration. It should be noted that gasoline figures in Louisiana do not represent gallons of gasoline consumed by motor vehicles as in Oregon and California, but total gallons for all purposes. Louisiana traffic increased 25.2 per cent from 1926 to 1930. Registration increased 14.9 per cent and gasoline consumption increased 36.4 per cent. Fragmentary data from Nebraska, where a small number of traffic stations were operated at changing locations from 1926 to 1930, indicate closer agreement in rates of increase of

TABLE 6.—*Comparison of motor vehicle registration, gasoline consumption, and highway traffic in Louisiana, 1926–1930*

Year	Registration	Index number	Gasoline consumption (gallons)	Index number	Traffic	Index number
1926	239, 500	100. 0	135, 428, 367	100. 0	104, 710	100. 0
1927	255, 000	106. 5	151, 702, 807	112. 0	116, 270	111. 0
1928	264, 293	110. 4	169, 046, 556	124. 8	116, 575	111. 3
1929	280, 868	117. 3	176, 645, 631	130. 4	130, 270	124. 4
1930	275, 283	114. 9	184, 781, 753	136. 4	131, 097	125. 2

traffic and gasoline consumption than in rates of increase of traffic and motor vehicle registration.

Statistics of gasoline consumption in the State of Colorado are available for a longer period of years than in any other State, i. e., since 1913. The rates of increase in motor vehicle registration and in gasoline consumption are very similar year by year between 1913 and 1925. After 1925 the increases in registration take place at a less rapid rate than the rates of increase in gasoline consumption for corresponding years. The figures of Table 7 present the data for comparison.

Table 7.—*Comparison of registration of motor vehicles and gasoline consumption in Colorado, 1913–1930*

Year	Registration [1]	Gasoline consumption		Index numbers		
		Net [1] (gallons)	Gross [1] (gallons)	Registration	Gasoline (net)	Consumption (gross)
1913	13, 000		5, 860, 855	5. 4		5. 9
1914	17, 756		10, 372, 238	7. 4		10. 5
1915	28, 894		14, 482, 629	12. 0		14. 7
1916	43, 296		19, 988, 001	18. 0		20. 2
1917	87, 460		29, 879, 153	36. 4		30. 3
1918	83, 244		32, 800, 910	34. 7		33. 2
1919	104, 865		42, 361, 550	43. 7		42. 9
1920	129, 255	[2] 45, 839, 482	51, 917, 098	53. 8	47. 1	52. 6
1921	145, 739	[2] 64, 491, 230	60, 390, 692	60. 7	66. 2	61. 2
1922	162, 328	69, 337, 164	65, 891, 200	67. 6	71. 2	66. 7
1923	188, 956	73, 753, 225	75, 258, 403	78. 7	75. 7	76. 2
1924	213, 247	92, 151, 131	94, 031, 766	88. 8	94. 6	95. 2
1925	240, 097	97, 377, 858	98, 741, 301	100. 0	100. 0	100. 0
1926	248, 613	104, 587, 460	112, 380, 309	103. 6	107. 4	113. 8
1927	268, 492	122, 493, 107	128, 304, 024	111. 8	125. 8	129. 9
1928	284, 867	130, 707, 467	142, 027, 665	118. 7	134. 2	143. 8
1929	303, 489	141, 466, 891	155, 507, 842	126. 4	145. 3	157. 5
1930	308, 509	153, 620, 645	170, 854, 939	128. 5	157. 8	173. 0

[1] As reported by State Inspector of Oils.
[2] Based on taxes collected in 1920 apparently reported in part with collections of 1921.

EFFECT OF PRESENT DEPRESSION ON FORECASTS IN WESTERN STATES

General trend lines were considered in arriving at figures in the Western States forecasts. Previous business slumps have checked the rate of decline in persons per car for a year or two, and in a few States for a longer period, but this ratio has always returned to its general trend, as is clearly illustrated in Figure 11.

Statistics show that while registration barely held its own in 1930, gasoline consumption and traffic have had definite increases.

MILES PER GALLON

Where data have been obtained on the operation of any considerable number of passenger cars it has been found that the average mileage per gallon is around 15 miles. Some individual records are as high as 23 miles per gallon, others as low as 11.

Some investigators have suggested 11,000 miles as an average annual mileage. Others indicate that the figure is much lower, from 6,000 to 10,000 miles.

Assuming 8,000 miles per year as the average travel of registered vehicles in the United States and dividing the number of gallons of gasoline consumed into the vehicle mileage, we obtain an average of 14.38 miles per gallon as the average rate of fuel consumption. Were the 11,000 miles per vehicle used, the result would be 19.78 miles per gallon for all vehicles.

The rapid increase in trucks registered during the decade 1920 to 1930 (246.0 per cent net) as compared to passenger cars registered (180.1 per cent net) very probably has had considerable effect upon miles per gallon for all vehicles.

However, trucks amounted to 10.9 per cent of total registration in 1920, and 13.1 per cent in 1930. If 15 miles per gallon were used for passenger cars and 8 miles per gallon for trucks, the weighted average in 1920 would be 14.24 miles per gallon as compared with 14.08 in 1930.

In a truck survey by the General Motors Corporation involving 46,000 trucks, the miles per gallon for light, medium, and heavy trucks are given. When weighted by per cent of each capacity, the average for all is 11.25 miles per gallon. Using 11.25 for trucks and the above 15 for passenger cars, the weighted average in 1920 was 14.59, and in 1930, 14.51 miles per gallon. In one case, the decrease was sixteen-hundredths, and the other eight-hundredths of a mile per gallon in the past 10 years. The point is that truck registration (including busses) is so small as compared to total registration that the reduction of miles per gallon for all vehicles is small indeed.

This small change in average mileage per gallon is an indication that little additional traffic may be estimated from this factor.

PERSONS PER MOTOR VEHICLE

The number of persons per car was found for each State from 1913 to 1930 and extended to 1940, based on population as of July 1. These data are shown graphically in Figure 11 for the years since 1914, 1915, or 1916. The number in 1913 is often more than double the 1915 or 1916 figure, and can not conveniently be shown on these charts.

The curves shown in Figure 11, are very similar in that during the first five or six years the decline was rapid. Also in most States, during 1921 and 1922, the descent of these trends was checked sharply, after which the curves became smooth and tended to flatten out more and more each year. Because of business conditions, the number of persons per car in 1930 was affected somewhat as in 1921 and 1922. States with large deviations from trend are as follows: Wyoming and New Mexico for 3 years; Idaho for 5 years; Arizona and Nevada for 2 years. Practically all States had a high or low registration during one of the years 1917, 1918, or 1919, a fact which caused persons per car to be above or below the general trend in one of these years.

Registration, therefore, during years of depression may be low when compared with the general trend. It is interesting to note the rapid recovery in most States in 1923 after the very sharp deviation from trend in 1921 and 1922.

The traffic forecasts were based largely upon projected increases in gasoline consumption. Consideration was given to the nature of the data on gasoline consumption (whether net or gross), to the amount of foreign traffic recorded within the State, and to local distribution of registration, gasoline consumption, and foreign traffic, before a specific forecast was made for a particular State. Each State was subdivided into two or more geographical sections according to density of population; and a forecast was made of the increase in traffic on the highway system within each area, on the basis of the projected increase in gasoline consumption, as modified by the considerations outlined above. Motor vehicle registration by counties was available in 9 of the 11 States, gasoline consumption by counties in but 4 States.

The estimated increases in traffic from 1930 to 1940 vary between 42 per cent in eastern Washington to 76

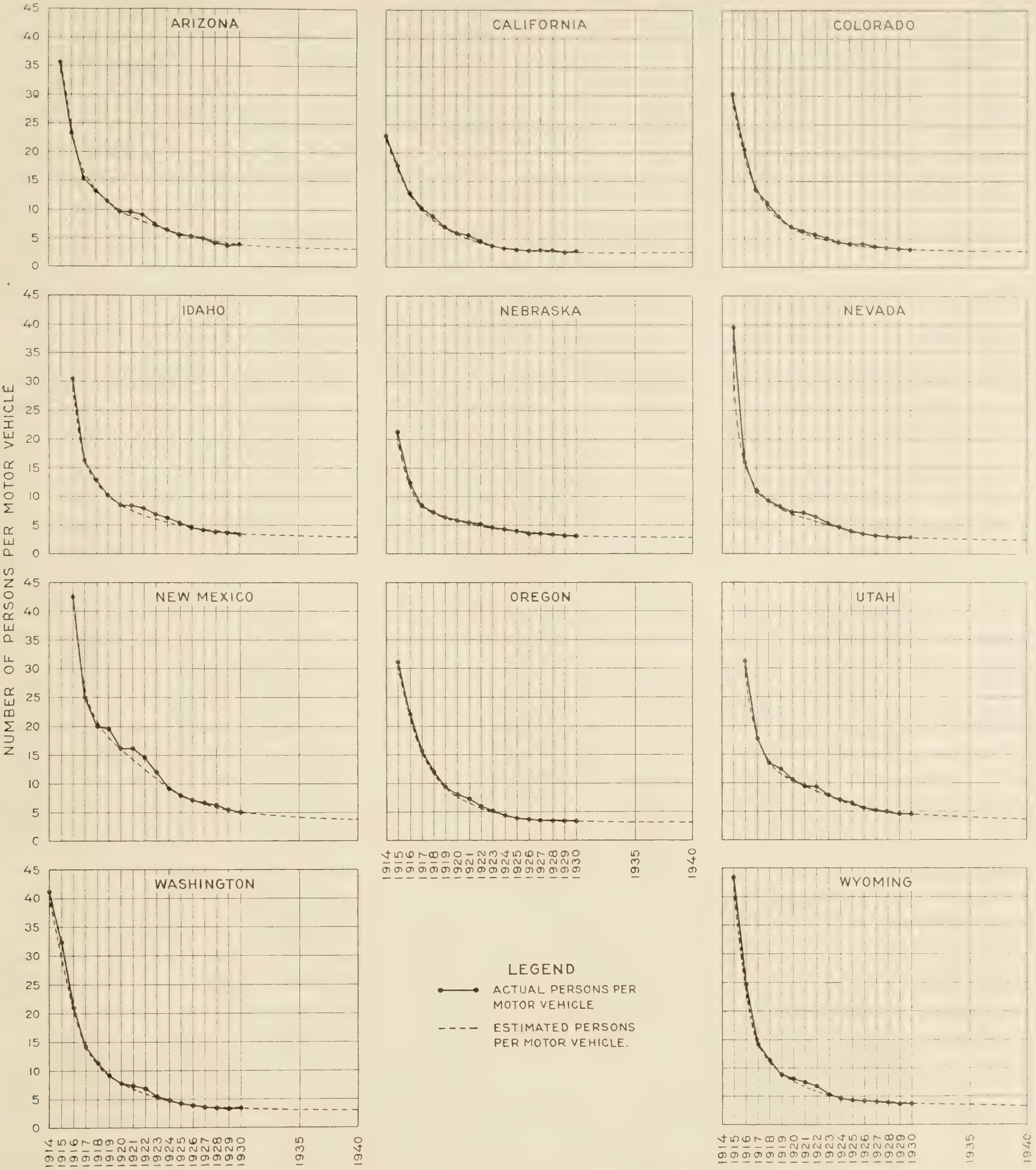


FIGURE 11.—CURVES SHOWING NUMBER OF PERSONS PER MOTOR VEHICLE IN WESTERN STATES DURING YEARS BETWEEN 1914 AND 1930. CURVES ARE PROJECTED TO SHOW PROBABLE VALUES FOR 1935 AND 1940

per cent in northern Arizona. For most of the area the traffic forecast varies between 45 and 60 per cent.

TRAFFIC CLASSIFICATION OF FEDERAL-AID SYSTEM IN WESTERN STATES

In the determination of a consistent program of economical highway improvement it is essential to consider the present traffic and also the traffic anticipated throughout the life of the proposed improvement, or as far ahead as reasonably accurate forecasts may be made. For this purpose the highway systems of the 11 survey States are classified in three groups according to average daily traffic density. A traffic of 1,500 or more vehicles per day is classified as heavy, 600 to 1,500 as intermediate, and under 600 as light. For the purposes of the forecast the classification is subdivided into groups A to G, as shown in Table 8.

TABLE 8.—*Scheme of classification for highways of Western States according to average daily traffic density in 1930 and predicted density in 1935 and 1940*

Classification	1930	1935	1940
A	Over 1,500	Over 1,500	Over 1,500
B	600-1, 500	Over 1,500	Over 1,500
C	600-1, 500	600-1, 500	Over 1,500
D	600-1, 500	600-1, 500	600-1, 500
E	Under 600	600-1, 500	600-1, 500
F	Under 600	Under 600	600-1, 500
G	Under 600	Under 600	Under 600

Sections of the system carrying an average traffic of 1,500 or more vehicles per day, or more than 30 heavy trucks per day when the total volume of traffic is close to 1,500, are classified as heavy in 1930. Those expected to carry this volume by 1935 or 1940 are classified as heavy in 1935 or 1940, respectively. Similarly, those sections carrying an average of between 600 and 1,500 vehicles per day are classified as intermediate in 1930, with corresponding classifications for additional sections in 1935 and 1940, as the predicted increase in traffic brings them within this range. Those sections carrying an average of less than 600 vehicles per day in 1930, 1935, or 1940 are classified as light traffic highways in the respective periods.

The classification covers the Federal-aid system as of June 30, 1930, and is based on mileage figures submitted by the various States. The routes are carried continuously through all cities regardless of population.

The distribution of road mileage in the Western States according to the classification adopted is shown in Figure 12. On this map roads or sections of roads falling into each of the eight classifications (A to G) given in Table 8 are designated by appropriate symbols. Those roads which it was found impossible to classify are shown in double dash line.

The mileage included in each classification group by individual States is summarized in Table 9, which indicates the general increase of heavy and intermediate traffic routes, the heavy traffic mileage increasing from 11.3 per cent of the total mileage in 1930, to 14 per cent in 1935, and to 16 per cent in 1940. Similarly the total of the heavy and intermediate routes increases from 29.3 per cent of the total mileage in 1930, to 36.1 per cent in 1935, and to 41 per cent in 1940.

Practically half the class A highways (heavy traffic in 1930), are found in California, with Washington and Oregon adding some 1,200 miles. The three coast States contain more than three-quarters of all the class A mileage. The remainder is distributed throughout the other States, in large degree according to the size and location of the centers of population.

The mileage coming into the heavy-traffic classification in 1935 and 1940 is by no means proportional to the mileage now included in this classification in the various States. According to the forecast Nebraska, Nevada, and New Mexico will practically quadruple their present heavy traffic mileage by 1940, while Wyoming, which now has none, will have 68 miles by that time. California and Washington, with their present large mileage of heavy traffic roads, show relatively little increase. Although Utah is low in class A mileage, present traffic is so concentrated that practically no increase in its heavy traffic mileage is likely to occur by 1940. Oregon, with 339 miles in classes B or C in 1930, adds the greatest mileage to its heavy traffic classification between 1930 and 1940.

TABLE 9.—*Mileage* [1] *of Federal-aid roads in the Western States falling within heavy, intermediate, and light classifications, on the basis of average daily traffic density in 1930 and predicted density in 1935 and 1940*

HEAVY

State	1930		1935		1940	
	Miles	*Per cent*	*Miles*	*Per cent*	*Miles*	*Per cent*
Arizona	115.1	5.8	165.9	8.3	178.9	9.0
California	2,015.9	39.5	2,272.1	44.5	2,339.1	45.8
Colorado	334.9	10.3	382.4	11.8	528.0	16.3
Idaho	109.6	3.5	155.1	5.0	221.2	7.1
Nebraska	66.4	1.1	190.9	3.3	245.7	4.2
Nevada	12.1	.8	29.5	1.9	50.1	3.2
New Mexico	25.5	.7	69.5	2.0	118.4	3.4
Oregon	440.5	13.3	581.8	17.5	779.6	23.4
Utah	169.9	9.6	172.7	9.8	172.7	9.8
Washington	772.4	24.6	949.8	30.3	1,030.9	32.9
Wyoming	--------	--------	52.8	1.5	67.9	1.9
Total	4,062.3	11.3	5,022.5	14.0	5,732.5	16.0

INTERMEDIATE

State	1930 Miles	1930 Per cent	1935 Miles	1935 Per cent	1940 Miles	1940 Per cent
Arizona	399.4	20.0	670.6	33.7	903.9	45.4
California	1,130.8	22.1	1,042.8	20.4	1,115.9	21.8
Colorado	722.5	22.4	925.8	28.6	1,091.1	33.7
Idaho	355.7	11.5	475.5	15.4	520.8	16.9
Nebraska	1,482.1	25.5	1,830.6	31.5	1,974.2	34.0
Nevada	55.2	3.5	90.2	5.7	80.6	5.1
New Mexico	321.2	9.3	660.2	19.2	953.4	27.8
Oregon	796.2	23.9	926.4	27.9	886.6	26.8
Utah	75.1	4.3	149.3	8.4	201.5	11.3
Washington	898.3	28.7	795.0	25.3	866.6	27.6
Wyoming	228.1	6.5	378.7	10.9	404.1	11.7
Total	6,464.6	18.0	7,945.1	22.1	8,998.7	25.0

LIGHT

State	1930 Miles	1930 Per cent	1935 Miles	1935 Per cent	1940 Miles	1940 Per cent
Arizona	1,441.4	72.5	1,119.4	56.3	873.1	43.9
California	1,857.5	36.3	1,689.3	33.0	1,549.2	30.3
Colorado	2,130.8	65.7	1,880.0	58.0	1,569.1	48.4
Idaho	2,343.6	75.9	2,178.3	70.5	2,066.9	66.9
Nebraska	3,449.7	59.5	2,976.7	51.3	2,778.3	47.9
Nevada	1,370.3	87.5	1,317.9	84.2	1,306.9	83.5
New Mexico	3,090.6	90.0	2,707.6	78.8	2,365.5	68.8
Oregon	1,995.0	60.2	1,723.5	52.0	1,565.5	47.2
Utah	1,518.3	85.4	1,441.3	81.1	1,389.1	78.2
Washington	1,368.3	43.6	1,294.2	41.3	1,141.5	36.4
Wyoming	3,109.9	89.9	2,906.5	84.0	2,866.0	82.8
Total	23,675.4	65.9	21,234.7	59.1	19,471.1	54.2

UNCLASSIFIED

State	1930		State	1930	
	Miles	*Per cent*		*Miles*	*Per cent*
Arizona	33.7	1.7	Oregon	86.8	2.6
California	105.9	2.1	Utah	12.0	.7
Colorado	50.8	1.6	Washington	97.6	3.1
Idaho	281.9	9.1	Wyoming	125.3	3.6
Nebraska	803.4	13.9			
Nevada	128.4	8.2	Total	1,725.8	4.8
New Mexico	--------	--------			

[1] Mileage as of June 30, 1930.

The distribution of the intermediate-traffic mileage is entirely different from that of the heavy-traffic mileage. Nebraska, with its more evenly distributed population and greater mileage of highway per square mile, leads in the intermediate-traffic mileage, with nearly 1,500 miles now in this classification. This class in Nebraska also shows a marked increase in 1935 and 1940, the mileage changing from the light to the intermediate classification far exceeding that changing from the intermediate to the heavy classification. This fact is true in a greater or less degree in every State except California and Washington.

The light-traffic highways decrease in all of the States during the 10-year period. California shows the

Figure 12.—Classification of Federal-Aid Highway System in the Western States on the Basis of Average Daily Traffic Density in 1930 and Predicted Density in 1935 and 1940. Scheme of Classification is Shown in Table 8

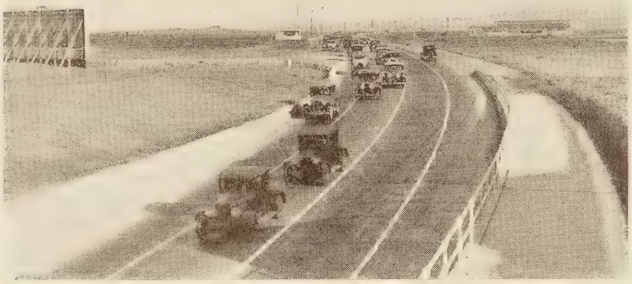
lowest percentage of this classification in all years, while Arizona shows the greatest decrease from 1930 to 1940. Nevada and Wyoming have the greatest mileage of this class, each with over 80 per cent still classed as light-traffic highways in 1940.

Of the various through routes, one is outstanding. U. S. 99, spanning the country from north to south through Washington, Oregon, and California, is expected by 1935 to carry heavy traffic throughout its entire length, with the exception of a short section at the Oregon-California line. This route now carries heavy traffic from Bellingham, Wash., to Drain, Oreg., and through California from Willows to El Centro. U. S. 101 from San Francisco to San Diego, although not an interstate route, carries heavy traffic throughout a distance of over 550 miles.

No east and west route is so heavily traveled as either of these. U. S. 80, from San Diego through Yuma, Phoenix, and Lordsburg to Las Cruces, whence it continues as U. S. 366 through New Mexico via Roswell and Clovis, is of heavy-traffic classification in 1930 only in southern California and in the vicinity of Phoenix. The traffic by 1940 will probably be such as to place practically the entire route in the intermediate or higher classification. Another relatively heavily traveled east-west route is U. S. 30, from

Omaha through Nebraska, Wyoming, Idaho, and Oregon to Astoria. The section from Omaha to Laramie is now, or by 1935 will be, classed as heavy or intermediate. From Laramie through Wyoming the route will not leave the light classification by 1940, with the exception of short sections near the various cities; but from McCammon, Idaho, through that State and Oregon to Astoria, all but a small portion will be in either the intermediate or heavy classification by 1935.

U. S. 40, the northern route to California, through Colorado, Utah, and Nevada, carries but little traffic based on the year-round average. The only sections of this route carrying traffic above the light classification are those in Colorado from the Kansas line to Denver, in the vicinity of the cities of Salt Lake City and Reno, and in California from Emigrant Gap to San Francisco.



Sunday Afternoon Traffic on Bayshore Highway Near South San Francisco

The only other through route carrying noticeably heavy traffic is U. S. 85 from El Paso through New Mexico, Colorado, and Wyoming. Over a good portion of this route—from Los Lunas, N. Mex., through Colorado to Cheyenne, Wyo.—the traffic falls in the intermediate or heavy classification.

Other routes or sections of routes carrying heavy or intermediate traffic can nearly all be found either within or connecting various economic areas. An examination of the traffic classification map (fig. 12) shows these areas well defined around Salt Lake City, Seattle, Spokane, San Francisco, and Los Angeles, and including eastern Nebraska, eastern Colorado, southern Idaho, and western Oregon and Washington. The location and extent of these routes show the insignificance of State lines or other artificial boundaries in determining traffic flow. The routes may be seen extending from State to State with little or no change in traffic classification, but changing noticeably as they progress from a center of population, or approach a natural barrier to travel.

A study of the changes in traffic classification during this 10-year period indicates its usefulness in the formulation of a long time plan of highway improvement.

PREPARATION OF PROGRAMS OF ROAD CONSTRUCTION

The traffic data provided by the survey may be used in each State as the basis for the preparation of a program of road construction, reconstruction, and maintenance consistent with traffic requirements during the ensuing 10-year period. For this purpose the characterization of traffic as heavy, intermediate, and light, and the classification of the various sections of highway according to the character of their present and probable future traffic density, are especially useful.

Traffic density is the most important general factor in highway planning. It is the multiplier that determines the amount of vehicular operating savings resulting from road improvements; and, particularly with respect to low and intermediate types of road surface, it has a determining effect upon the life and maintenance cost of the surface. It also influences strongly the choice of surface width and others of the many decisions that must be made in the development of the highway plan.

It is a recognized principle of highway finance that the expenditure for road improvement should be kept within the earning capacity of the improvement. The return to the public upon its highway investment takes the form of reductions in the operating cost of vehicles resulting from the greater ease of traction over the improved grades and surfaces and the reduced wear and tear of vehicles consequent upon the road improvement. With increase in the movement of vehicles there is greater accumulation of individual savings and increase of the amount that may justifiably be expended to obtain further benefits.

The traffic data supplied by this survey and the estimates of future traffic density based upon them afford the needed safeguard against unwise overexpenditure by indicating the amount of the vehicular operating saving that may be expected from the improvement of each section of road during the next 10 years. But the more positive value to the highway designer lies in the usefulness of the data, when intelligently employed, in determining the character of improvement required immediately by each section of the highway system and the future alterations in the form of present improvements that will probably be required by changes in the density of traffic during the 10-year period covered by the estimates.

The area covered by the survey is economically youthful. Traffic upon many of its roads is in an early stage of development and, at its present density, requires and will yield a compensatory return upon only a minimum improvement of the road surface. As traffic increases a point will be reached at which, because of the wear and cost of maintaining the surface, it will become cheaper to replace the initial low-type surface with a surface of intermediate cost and resistance to traffic. At the same time the greater savings accumulated by the increased operation of vehicles will support the greater investment in the higher type of road improvement. There are numerous sections on which the traffic, as indicated by the survey, has already reached the density that suggests such an intermediate type of road improvement.

With further increase of traffic the roads now or subsequently to be improved with intermediate types of surface will require for maximum economy a still further improvement by addition of high-type pavements; and again, as the data of the survey show, there are already many sections that have reached this degree of utilization.

It is not possible to fix upon any precise density of traffic, uniformly acceptable under the varied conditions obtaining in the several States, as the density at which a substitution of an intermediate for a low type of surface or a high for an intermediate type will become profitable.

The proper time for change is indicated by increase of the true annual cost of the lower type of surface with increase of traffic to an amount exceeding the estimated

Typical Western Road Surfaces

A—Gravel in Wyoming. B—Bituminous Concrete in Oregon. C—Gravel in Nevada. D—Portland Cement Concrete in California. E—Crushed Rock in Idaho. F—Bituminous Surface Treatment in California. G—Crushed Caliche in New Mexico. H—Graded Earth in New Mexico. I—Oil-Treated Gravel in Idaho annual cost under the same density of traffic for the higher, more resistant, and more expensive type of surface. But the annual costs of the various types of surface under various densities of traffic are affected both absolutely and relatively by the different conditions of the various parts of an area of such diverse conditions as the wide territory covered by this survey. Even within an individual State it may be impracticable to base highway design upon a single relation of traffic density and road type. Where, as in this case, there are 11 States and a range of natural conditions from mountain to plain, from arid to humid, from cold to hot, it is quite impossible to apply a uniform rule.

To illustrate, consider the traffic suitability of the gravel surface, a familiar and widely used low type. The annual cost of a gravel surface involves first the sum derived by dividing the difference between the cost of construction and the salvage value at the time of replacement by the time in years between construction and reconstruction. To this is added the annual interest on the capital invested and the annual cost of maintenance under the traffic to which the surface is actually subjected.

Obviously this annual cost will be affected by differences in the cost of the gravel and by differences in the character of the gravel which will cause the surface to wear more or less rapidly under traffic of various intensities and thus influence the life of the surface. The character of the subgrade upon which the surface is laid and the general climatic conditions obtaining will also have important bearing, as will several other variable conditions.

Similar variable conditions also affect the annual cost of the higher types of surface that may be considered for substitution in place of the gravel surface. So that it is impossible to fix upon any single density of traffic that may be uniformly used throughout such an area as the territory of this survey as the criterion of change from gravel to bituminous macadam or other higher type of surfacing.

For reasons such as this it is impossible to attempt in this report to establish the desirable highway program in all the 11 States. The current traffic data and the estimates of future density supplied constitute the principal basis of such programs; but the establishment of the programs is a task that must be left to the several State highway departments familiar with the present condition of the various highways and the various conditions, such as the cost and character of available road materials, and the effect of the existing climate and soils upon surfaces built of such materials.

Moreover, there will be special cases in which traffic density or tangible economy will not be controlling factors in determining the type of road improvement. Such cases may be expected to be rather more numerous in these Western States than in other more fully developed areas. In remote mountain and desert regions, for example, it is quite possible that the type of road improvement may be determined by such factors as the convenience, safety, comfort, and speed of traffic to a greater degree than by the more tangible factors of traffic density and cost.

In all cases, however, the tables and maps contained in the report, showing as they do the average daily density of traffic upon all sections of the Federal-aid highway system at the time of the survey and the estimated density after 5 and 10 years, respectively, will serve as a reliable guide in the establishment of the highway program. The characterization of the traffic as light, intermediate, and heavy according as its average daily density is less than 600, between 600 and 1,500, and over 1,500 vehicles, respectively, and the classification of the various road sections according to this denomination of their traffic at the three periods, represent efforts to reduce the data to a practically usable form. The limits assigned to the three classes of traffic, that is, 600 and 1,500 vehicles per day, are not to be construed as traffic densities indicative of the need of low, intermediate, or high type surfaces; although, in the general way possible under the circumstances, modified as necessary by other known facts, the passage of a section of road from one to the other of the resulting classes may be accepted as an index of traffic growth critical in its bearing upon highway design.

TRUCK GREAT FACTOR IN FARM FREIGHTING

MOTOR trucks are hauling approximately 15 per cent of the total shipments of fresh fruits and vegetables transported 20 or more miles to market, according to a survey made recently by the Bureau of Agricultural Economics. Motor-truck shipments of 20 or more miles in 1929 are estimated by the bureau at between 150,000 and 200,000 cars, as compared with 1,068,745 cars transported by rail and boat lines. This represents a large percentage increase in motor-truck hauls in recent years, but it is pointed out that rail and boat shipments have practically doubled in the last 10 years. On a mileage basis the percentage of motor trucks to total shipments is much less than 15 per cent because of the longer average haul by railroads.

In areas covered by the survey motor-truck hauls ranged from 2 to 92 per cent of the shipments which went 20 or more miles in those areas in 1928, the high figure being for the State of Connecticut. In Southwestern Michigan 73 per cent of the shipments going 20 or more miles to market go by motor truck; on Long Island, 68 per cent; in the Hudson Valley, 67 per cent; central and southern New Jersey, 67 per cent; Delaware, 41 per cent; southern Indiana, 37 per cent; eastern shore of Maryland, 24 per cent; western Maryland, 24 per cent; southern Illinois, 21 per cent; western New York, 19 per cent; south central Pennsylvania, 18 per cent; western Massachusetts, 7 per cent; eastern shore of Virginia, 3 per cent; and the West Virginia, Cumberland, Shenandoah Valley region, 2 per cent. Motor-truck hauls in these areas totaled 77,102 cars,as against 136,509 cars carried by rail and boat. In important producing areas remote from large markets—Florida, southern Texas, California, the Northwestern States, and northern Maine—the percentage of shipments hauled by motor truck is much smaller than in some of the areas covered by the survey.

The bureau investigated truck receipts at city markets and trade and operating practices of truckmen, farmers, truckmen carriers, and truckmen merchants, and studied the economic aspects of shipping by truck in their effect upon distribution and production.

The following is a summary of some of the information brought out by the survey:

Trucks have expedited transportation on short hauls and have made the distribution of highly perishable products more direct and less wasteful under certain conditions.

Regional motor-truck jobbing markets, where products from a considerable area are concentrated and redistributed, and wholesale roadside stands, are increasing in number to serve the motor-truck trade.

Products most suited to long-distance transportation by motor truck are the light, quickly perishable fruits and vegetables or those that yield a high freight revenue and require expeditious movement to market.

Distances covered by trucks have increased; highly perishable products are now being hauled regularly for distances as great as 400 miles, and even greater distances in some areas.

For all the areas in north central and northeastern United States that were studied the relation which motor-truck shipments of important commodities bore to the total shipments was, in terms of percentage: Spinach, 96; snap beans, 89; mushrooms, 85; asparagus, 76; tomatoes, 64; strawberries, 58; cantaloupes, 49; grapes, 48; peaches, 43; potatoes, 25; apples, 24; lettuce, 21; sweet potatoes, 19; onions, 18; and cabbage, 12.

The truck unloads of fruits and vegetables at the 11 cities studied, excluding market-garden receipts, were of greatest relative importance at Los Angeles where they were 57 per cent of the total of unloads for the city, and of least relative importance at Boston, where they were only 2 per cent of the total unloads.

Redistribution from city markets to surrounding trade territories has grown in volume and in distance. Except for local supplies, the area within 50 miles is now usually supplied with fruits and vegetables by truck from the large city market. In the outer rim of the trade territory, up to 150 miles, and sometimes farther, trucks compete with mixed cars and express shipments from the large city and with straight cars shipped direct from producing areas.

It was estimated that 50 per cent of the total receipts on the wholesale markets at Pittsburgh was trucked out of the metropolitan area in the spring of 1930, and at Baltimore 24 per cent was trucked out.

Country cold-storage plants aid motor-truck transportation by prolonging the trucking season. The use of the truck facilitates quick movement of apples into storage after packing, which is a decided advantage. Canning-plant managers are using trucks to obtain more soft fruits and tomatoes of desirable maturity and to extend the area from which supplies are received.

PROGRAMS OF ESTIMATED STATE AND LOCAL HIGHWAY AND BRIDGE EXPENDITURES FOR CALENDAR YEAR 1932

(As reported by State authorities)

State	Grand total expenditures (estimated) on State and local roads	Probable expenditures by State highway departments: Total State road expenditures	Construction expenditures: Total roads and bridges	Construction expenditures: Roads	Construction expenditures: Bridges	Maintenance [1]: Reconstruction	Maintenance [1]: Road upkeep	Interest payments, State highway and bridge bonds	Miscellaneous, including overhead	Probable expenditures on roads and bridges by local authorities	Estimated road mileage to be built by State highway departments: Total mileage	Earth, improved	Sand-clay, gravel, and macadam	Asphalt, concrete, and brick	Miles of State roads maintained by State highway department
Alabama	$8,791,625	$5,291,625	$1,250,000	$1,050,000	$200,000		$2,000,000	$1,866,625	$175,000	$3,500,000	125	50	75		5,207
Arizona	8,600,000	6,100,000	4,350,000	4,050,000	300,000		1,260,000		550,000	2,500,000	360	105	250	5	2,635
Arkansas	10,855,300	8,555,300	(2)				1,500,000	[3] 6,980,300	75,000	2,300,000	(2)				7,500
California	69,600,000	36,400,000	23,000,000	20,000,000	3,000,000		6,000,000	2,800,000	4,600,000	33,200,000	520	50	60	410	7,103
Colorado	10,426,000	7,926,000	5,444,000	5,244,000	200,000		1,800,000	265,000	417,000	2,500,000	362	30	306	26	[4] 4,610
Connecticut	18,572,250	15,572,250	11,250,000	10,800,000	450,000		2,725,000	192,250	1,405,000	[5] 3,000,000	(6)				2,050
Delaware	4,328,000	2,948,000	2,324,000	2,124,000	200,000		363,000	116,000	205,000	1,380,000	100		25	75	960
Florida	10,139,000	8,139,000	4,107,501	3,142,901	964,600	$2,445,490	1,331,609		255,000	[5] 2,000,000	(6)				5,359
Georgia	20,500,000	16,500,000	13,250,000	12,750,000	500,000		2,250,000		1,000,000	[5] 4,000,000	850	200	50	600	7,138
Idaho	5,826,250	4,326,250	2,780,000	2,550,000	230,000		1,250,000	46,250	250,000	1,500,000	622	8	614		3,080
Illinois	79,080,000	51,080,000	37,500,000	35,500,000	2,000,000		5,250,000	5,830,000	2,500,000	28,000,000	1,000			1,000	11,000
Indiana	44,975,580	28,045,580	20,196,000	14,096,000	6,100,000		4,400,000		3,449,580	16,930,000	450	[5] 25	[5] 25	[5] 400	6,964
Iowa	40,298,000	20,298,000	11,000,000	9,500,000	1,500,000		3,110,000	[3] 4,340,000	1,848,000	20,000,000	1,225	350	675	200	7,260
Kansas	17,350,000	13,750,000	8,000,000	7,000,000	1,000,000	1,250,000	3,500,000		1,000,000	3,600,000	1,243	343	800	100	8,690
Kentucky	27,030,000	22,030,000	15,500,000	11,000,000	4,500,000		5,000,000	30,000	1,500,000	5,000,000	950	[5] 400	[5] 350	[5] 200	6,000
Louisiana	39,642,375	33,642,375	25,000,000	21,000,000	4,000,000		3,500,000	2,417,375	2,725,000	6,000,000	2,300	300	1,400	600	10,500
Maine	21,464,420	16,464,420	11,820,000	9,570,000	2,250,000		2,900,000	879,420	865,000	5,000,000	579		496	83	5,000
Maryland	13,458,316	10,958,316	6,046,075	3,790,542	2,255,533	2,802,241	2,110,000		(7)	[5] 2,500,000	290		90	200	3,446
Massachusetts	21,443,000	17,443,000	10,350,000	8,850,000	1,500,000	3,500,000	3,175,000	256,000	162,000	4,000,000	310		70	240	[8] 1,770
Michigan [9]	52,560,000	30,560,000	22,000,000	18,500,000	3,500,000		6,000,000	2,300,000	260,000	22,000,000	700	350	100	250	[10] 8,275
Minnesota	48,500,000	32,000,000	22,600,000	21,300,000	1,300,000	500,000	4,000,000	[3] 1,700,000	3,200,000	16,500,000	1,130	400	300	430	7,000
Mississippi	4,725,000	3,225,000	1,025,000	1,000,000	25,000		2,000,000		200,000	1,500,000	50	25		25	6,000
Missouri	52,906,300	40,906,300	31,106,300	30,778,000	328,300		4,500,000	3,800,000	1,500,000	12,000,000	4,517	2,105	2,034	378	9,000
Montana	11,950,000	6,950,000	5,000,000	4,000,000	1,000,000	250,000	1,000,000	100,000	600,000	5,000,000	900	450	450		3,500
Nebraska	18,350,000	10,350,000	6,600,000	6,000,000	600,000		3,250,000		500,000	8,000,000	1,025	100	800	125	7,400
Nevada	4,323,200	3,613,200	2,841,200	2,743,200	98,000		540,000	40,000	192,000	710,000	295	31	250	14	2,100
New Hampshire	8,867,000	6,867,000	3,700,000	3,500,000	200,000		2,000,000	592,000	575,000	2,000,000	150		100	50	2,500
New Jersey	67,187,243	45,568,601	28,275,457	15,100,457	13,175,000	1,000,000	2,500,000	7,371,475	6,421,669	21,618,642	128	30		98	1,400
New Mexico	5,856,312	5,656,312	3,180,000	2,615,000	565,000		1,200,000	536,312	740,000	200,000	312	11	295	6	5,700
New York	113,642,693	63,642,693	49,522,693	41,860,228	7,662,465		10,000,000	4,120,000	(7)	50,000,000	724	(11)	(11)	(11)	11,657
North Carolina	27,103,198	18,221,648	3,900,000	3,400,000	500,000		[12] 9,250,000	4,726,648	345,000	8,881,550	325		250	75	[13] 9,700
North Dakota	9,232,000	5,732,000	4,000,000	3,800,000	200,000		1,332,000		400,000	3,500,000	1,870	730	1,140		6,000
Ohio	63,500,000	33,500,000	20,500,000	17,000,000	3,500,000		13,000,000		(7)	30,000,000	955	35	150	[14] 770	11,743
Oklahoma	26,155,159	15,084,612	9,800,000	8,300,000	1,500,000	945,000	3,428,422		911,190	11,070,547	1,750	350	1,200	200	7,018
Oregon	19,000,000	11,000,000	5,500,000	5,000,000	500,000		3,000,000	1,340,000	1,160,000	8,000,000	325	150	170	5	[15] 3,800
Pennsylvania	118,830,000	68,830,000	34,800,000	34,800,000			22,500,000	3,830,000	7,700,000	50,000,000	2,700		2,600	100	34,074
Rhode Island	5,307,540	4,307,540	2,950,000	2,500,000	450,000		950,000	127,540	280,000	1,000,000	40			40	602
South Carolina [16]	13,550,000	8,550,000	5,000,000	[17] 5,000,000			2,000,000	1,100,000	450,000	5,000,000	(2)				5,907
South Dakota	10,230,000	6,230,000	3,530,000	3,330,000	200,000	75,000	2,125,000		500,000	4,000,000	718	290	400	28	5,250
Tennessee	14,550,000	10,050,000	3,600,000	3,000,000	600,000		3,500,000	2,300,000	650,000	4,500,000	180	20	10	150	7,500
Texas	60,000,000	45,050,000	32,000,000	28,000,000	4,000,000		12,000,000		1,050,000	14,950,000	2,500	1,325		1,175	18,868
Utah	5,675,000	4,475,000	2,750,000	2,150,000	600,000		1,300,000	325,000	100,000	1,200,000	454	20	427	7	4,092
Vermont [18]	5,837,500	5,087,500	2,650,000	2,500,000	150,000	500,000	1,500,000	262,500	175,000	750,000	160	30	85	45	1,013
Virginia	23,780,000	18,780,000	12,000,000	11,000,000	1,000,000		6,000,000	160,000	620,000	[5] 5,000,000	633	31	404	198	8,032
Washington	24,000,000	12,000,000	9,500,000	8,500,000	1,000,000	1,000,000	1,500,000			12,000,000	591	142	357	92	3,505
West Virginia	24,445,000	16,945,000	10,800,000	9,800,000	1,000,000		2,850,000	2,925,000	370,000	7,500,000	479	230	132	117	3,711
Wisconsin	33,760,000	17,760,000	11,900,000	11,000,000	900,000	906,000	4,094,000		860,000	16,000,000	523	73	104	346	10,186
Wyoming	6,634,000	5,134,000	3,600,000	3,350,000	250,000		950,000	184,000	400,000	1,500,000	675	210	465		3,125
Total	1,352,837,261	881,546,522	567,798,226	491,844,328	75,953,898	15,173,731	181,573,431	63,859,695	53,141,439	471,290,739	[19] 36,095	8,999	17,509	8,863	314,930

Remark: Above expenditures exclude State bond payments on principal.

1 When reconstruction is reported under "Maintenance" it is so shown; otherwise it is included with "Construction expenditures."

2 No construction contemplated in 1932.

3 Includes interest payments on local road bonds assumed by State.

4 Excludes 261 miles of forest roads maintained by State.

5 Estimate based on 1931 program.

6 Mileage not reported.

7 Included in construction and maintenance.

8 Excludes 8,000 miles of town roads maintained by State.

9 Excludes $4,000,000 for city street widening and $1,158,000 for maintenance of city streets under supervision of State Highway Department.

10 Excludes 343 miles of city streets maintained by State.

11 Types of mileage to be constructed not segregated.

12 Includes $6,000,000 for county road maintenance by State highway department.

13 Excludes 46,980 miles of county roads maintained by State highway department.

14 Includes 350 miles to be widened and resurfaced.

15 Excludes 2,000 miles of secondary highways maintained by State.

16 Excludes $4,656,402 for reimbursements of counties for county bond payments.

17 Amount payable on previous year's uncompleted work; no new State construction contemplated in 1932.

18 Unofficial estimate reported by bureau engineer.

19 Includes 724 miles in New York not included in mileage totals by types of road.

ROAD PUBLICATIONS of the BUREAU OF PUBLIC ROADS

ANNUAL REPORTS

Report of the Chief of the Bureau of Public Roads, 1924.
Report of the Chief of the Bureau of Public Roads, 1925.
Report of the Chief of the Bureau of Public Roads, 1927.
Report of the Chief of the Bureau of Public Roads, 1928.
Report of the Chief of the Bureau of Public Roads, 1929.

DEPARTMENT BULLETINS

*No. 136D . . Highway Bonds. 20 cents.

*No. 347D . . Methods for the Determination of the Physical Properties of Road-Building Rock. 10 cents.

*No. 532D . . The Expansion and Contraction of Concrete and Concrete Roads. 10 cents.

*No. 583D . . Reports on Experimental Convict Road Camp, Fulton County, Ga. 25 cents.

*No. 660D . . Highway Cost Keeping. 10 cents.

No. 1279D . . Rural Highway Mileage, Income, and Expenditures, 1921 and 1922.

No. 1486D . . Highway Bridge Location.

TECHNICAL BULLETINS

No. 55T . . Highway Bridge Surveys.

No. 265T . . Electrical Equipment on Movable Bridges.

SEPARATE REPRINT FROM THE YEARBOOK

No. 1036Y . . Road Work on Farm Outlets Needs Skill and Right Equipment.

MISCELLANEOUS CIRCULARS

No. 62MC . . Standards Governing Plans, Specifications, Contract Forms, and Estimates for Federal-Aid Highway Projects.

*No. 93MC . . Direct Production Costs of Broken Stone. 25c.

No. 109MC . . Federal Legislation and Regulations Relating to the Improvement of Federal-Aid Roads and National-Forest Roads and Trails, Flood Relief, and Miscellaneous Matters.

MISCELLANEOUS PUBLICATION

No. 76MP . . The Results of Physical Tests of Road-Building Rock.

TRANSPORTATION SURVEY REPORTS

Report of a Survey of Transportation on the State Highway System of Ohio. (1927.)

Report of a Survey of Transportation on the State Highways of Vermont. (1927.)

Report of a Survey of Transportation on the State Highways of New Hampshire. (1927.)

Report of a Plan of Highway Improvement in the Regional Area of Cleveland, Ohio. (1928.)

Report of a Survey of Transportation on the State Highways of Pennsylvania. (1928.)

Report of a Survey of Traffic on the Federal-Aid Highway Systems of Eleven Western States. (1930.)

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH

Vol. 5, No. 17, D- 2 . . Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cement.

Vol. 5, No. 19, D- 3 . . Relation Between Properties of Hardness and Toughness of Road-Building Rock.

Vol. 5, No. 24, D- 6 . . A New Penetration Needle for Use in Testing Bituminous Materials.

Vol. 11, No. 10, D-15 . . Tests of a Large-Sized Reinforced-Concrete Slab Subjected to Eccentric Concentrated Loads.

REPRINT FROM PUBLIC ROADS

Reports on Subgrade Studies.

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PLEASE NOTE: Applicants are urgently requested to ask only for those publications in which they are particularly interested. • The Department can not undertake to supply complete sets nor to send free more than one copy of any publication to any one person. • The editions of some of the publications are necessarily limited, and when the Department's free supply is exhausted and no funds are available for procuring additional copies, applicants are referred to the Superintendent of Documents, Government Printing Office, Washington, D. C., who has them for sale at a nominal price, under the law of January 12, 1895. • Those publications in this list the Department supply of which is exhausted can only be secured by purchase from the Superintendent of Documents, who is not authorized to furnish publications free. • • • • Numbers marked with an asterisk [*] indicate Department supply is exhausted.

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

CURRENT STATUS OF FEDERAL-AID ROAD CONSTRUCTION

AS OF

FEBRUARY 29, 1932

STATE	COMPLETED MILEAGE	UNDER CONSTRUCTION					APPROVED FOR CONSTRUCTION					BALANCE OF FEDERAL-AID FUNDS AVAILABLE FOR NEW PROJECTS	STATE
		Estimated total cost	Federal-aid allotted	MILEAGE			Estimated total cost	Federal-aid allotted	MILEAGE				
				Initial	Stage[1]	Total			Initial	Stage[1]	Total		
Alabama	2,405.5	$ 1,516,104.91	$ 736,156.40	62.5		62.5	$	$				$ 5,432,927.22	Alabama
Arizona	1,153.8	2,777,948.05	1,903,875.08	157.7	57.4	215.1						1,538,171.97	Arizona
Arkansas	1,933.8	3,268,569.64	1,532,812.22	73.9	67.8	141.7	362,032.53	181,016.26	17.3		17.3	2,022,780.34	Arkansas
California	2,258.0	10,627,452.90	4,735,006.60	217.0	38.4	255.4	2,068,582.60	1,132,801.37	60.2	0.3	60.5	1,140,445.57	California
Colorado	1,525.4	5,327,506.01	2,727,704.45	219.4	66.2	285.6	352,906.90	172,218.97	14.4	3.1	17.5	2,031,769.87	Colorado
Connecticut	288.5	3,084,244.77	1,151,757.90	22.9		22.9						713,252.14	Connecticut
Delaware	361.6	302,770.00	151,385.00	15.2		15.2	416,243.25	208,121.62	18.8	2.5	21.3	288,388.31	Delaware
Florida	591.6	5,129,634.73	2,325,684.09	137.1		137.1	49,004.56	24,502.28	.1		.1	2,995,441.71	Florida
Georgia	3,042.5	6,035,595.78	2,805,155.19	144.0	150.1	294.1	765,826.90	382,913.43	37.9	8.4	46.3	1,858,089.10	Georgia
Idaho	1,485.3	1,726,513.35	998,918.80	85.9	80.3	166.2	507,309.62	306,240.89	28.5	8.8	37.3	1,273,887.54	Idaho
Illinois	2,631.6	23,516,320.34	10,992,229.09	694.2	28.7	722.9	3,380,155.14	1,357,398.18	110.7	12.8	123.5	2,620,147.69	Illinois
Indiana	1,779.4	7,932,830.68	3,890,986.20	210.0		210.0	4,368,682.66	2,042,480.46	163.9	7.3	171.2	1,015,757.76	Indiana
Iowa	3,390.6						2,294,391.13	1,073,198.25	88.6	38.4	127.0	1,726,606.95	Iowa
Kansas	3,655.5	2,772,849.63	1,295,773.35	155.3	15.3	170.6	3,217,254.92	1,573,735.01	215.4	5.4	220.8	1,653,758.28	Kansas
Kentucky	1,876.1	2,371,724.06	1,078,977.39	142.2	4.0	146.2	554,263.03	257,680.28	8.3	41.6	49.9	1,762,284.08	Kentucky
Louisiana	1,541.5	7,216,064.49	2,803,668.96	112.6	10.6	123.2	1,295,507.93	68,270.07	.5		.5	1,669,179.62	Louisiana
Maine	706.0	1,804,346.15	789,080.76	31.4		31.4	1,092,164.18	407,145.00	27.1		27.1	930,066.82	Maine
Maryland	777.3	269,787.15	63,776.89	6.2		6.2	327,551.20	163,776.59	14.4		14.4	753,906.63	Maryland
Massachusetts	814.8	7,521,359.24	3,084,570.77	66.8	.2	67.0						688,428.02	Massachusetts
Michigan	1,974.3	10,508,444.69	4,558,432.69	384.7	58.2	442.9	871,983.39	348,545.34	43.0	10.4	53.4	3,163,346.35	Michigan
Minnesota	4,236.4	2,777,858.36	945,585.45	41.1	71.2	112.3	7,435,259.56	2,406,185.76	164.4	182.5	346.9	299,654.50	Minnesota
Mississippi	1,792.4	4,006,906.57	1,964,657.82	169.4	78.0	247.4	103,524.13	51,762.05	9.5		9.5	5,390,115.02	Mississippi
Missouri	2,961.9	2,128,677.12	873,611.16	49.0	3.4	52.4	2,340,093.19	1,045,562.84	81.4	10.3	91.7	2,765,682.31	Missouri
Montana	2,659.9	4,714,534.97	2,650,928.65	405.6	17.6	423.2	403,394.86	224,368.61	61.5	.5	62.0	3,409,512.56	Montana
Nebraska	4,143.8	5,045,660.06	2,469,130.70	213.8	76.6	290.4	341,832.91	170,752.29	13.9		13.9	2,535,115.92	Nebraska
Nevada	1,352.3	1,188,334.90	915,071.55	40.1	73.6	113.7						1,387,101.79	Nevada
New Hampshire	417.2	676,512.12	265,632.44	13.4	2.5	15.9						547,810.24	New Hampshire
New Jersey	596.7	4,537,831.05	1,624,072.73	44.9	.6	45.5						1,604,603.13	New Jersey
New Mexico	2,166.3	2,839,017.62	1,846,283.94	135.7	24.3	160.0	390,818.65	245,489.48	14.1		14.1	1,285,729.48	New Mexico
New York	3,262.5	11,450,810.00	5,290,930.00	267.7		267.7	4,429,800.00	1,736,750.00	86.5		86.5	3,937,031.23	New York
North Carolina	2,222.0	1,323,877.49	640,966.07	69.7		69.7	144,243.14	72,121.56	8.0	4.0	12.0	3,873,930.55	North Carolina
North Dakota	5,117.4	1,828,691.83	918,958.57	160.4	171.9	332.3	1,327,226.48	679,129.08	149.7	259.5	409.2	2,097,184.05	North Dakota
Ohio	2,847.8	6,806,145.56	2,366,982.51	96.0	19.2	115.2	749,700.00	366,240.00	11.6		11.6	4,114,890.49	Ohio
Oklahoma	2,210.3	4,804,687.46	2,333,810.09	129.1	75.4	204.5	905,270.12	429,123.79	64.7		64.7	2,114,538.86	Oklahoma
Oregon	1,537.0	3,770,922.17	2,076,608.52	93.9	47.1	141.0	134,459.60	83,674.19	11.8		11.8	1,795,507.85	Oregon
Pennsylvania	3,012.1	4,193,848.20	1,917,622.88	45.8		45.8	993,951.13	453,155.32	32.0		32.0	4,705,730.74	Pennsylvania
Rhode Island	257.5	809,280.68	400,528.17	16.6		16.6	81,305.62	40,652.81		2.2	2.2	338,736.37	Rhode Island
South Carolina	1,996.3	2,679,138.08	1,148,707.78	63.0	43.6	106.6						1,405,597.62	South Carolina
South Dakota	4,035.8	3,157,197.01	1,748,253.45	185.9	175.3	361.2	475,473.18	318,254.13	81.9		81.9	1,136,687.89	South Dakota
Tennessee	1,666.8	796,986.37	394,765.99	24.6	4.4	29.0	531,028.30	249,959.55	14.1	6.4	20.5	3,830,871.62	Tennessee
Texas	7,574.5	13,699,494.07	6,196,407.60	716.2	162.3	878.5	2,384,760.40	1,084,444.04	166.4	54.8	221.2	6,506,492.19	Texas
Utah	1,218.5	690,137.33	482,342.89	60.9	.4	61.3	316,975.19	234,536.62	21.6	3.3	24.9	1,325,708.11	Utah
Vermont	339.1	104,832.58	52,345.06	4.3		4.3						572,077.12	Vermont
Virginia	1,861.1	2,551,746.35	1,222,025.16	134.3	16.3	150.6	325,632.43	162,816.21	28.1		28.1	2,013,258.14	Virginia
Washington	1,195.3	2,325,797.79	1,120,168.56	75.1		75.1	657,348.73	280,800.00	22.1	11.1	33.2	1,556,569.91	Washington
West Virginia	882.9	1,735,051.39	761,625.34	44.6	10.5	55.1	187,685.92	86,032.31	.7		.7	1,238,151.24	West Virginia
Wisconsin	2,673.5	2,818,682.42	1,075,507.70	131.1	7.8	138.9	110,272.34	50,000.00	1.1	3.5	4.6	2,699,689.10	Wisconsin
Wyoming	2,029.9	2,473,695.98	1,469,907.17	186.1	76.6	262.7	656,430.97	425,448.15	33.7	64.4	98.1	626,649.18	Wyoming
Hawaii	63.1	974,113.04	445,557.39	30.0		30.0	82,324.99	22,869.00	1.5		1.5	2,018,071.60	Hawaii
TOTALS	100,523.4	200,620,534.13	93,244,947.17	6,587.3	1,735.8	8,323.1	47,422,671.78	20,620,170.79	1,929.4	741.5	2,670.9	102,411,334.78	TOTALS

[1] The term stage construction refers to additional work done on projects previously improved with Federal-aid. In general, such additional work consists of the construction of a surface of higher type than was provided in the initial improvement.

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